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(54) **Heat Exchange Tube Apparatus**

(57) Tube apparatus, particularly reaction apparatus for carrying out catalytic reactions, comprises an annular contact tube bundle through which a recirculated heat transfer medium can be passed in a radial direction in at least one position. To reduce the resistance to flow of the heat transfer medium, the ratio of the outer diameter to the inner diameter of the annular contact tube bundle is $\leqslant 5:1$, preferably $\leqslant 4:1$.

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Fig. 1

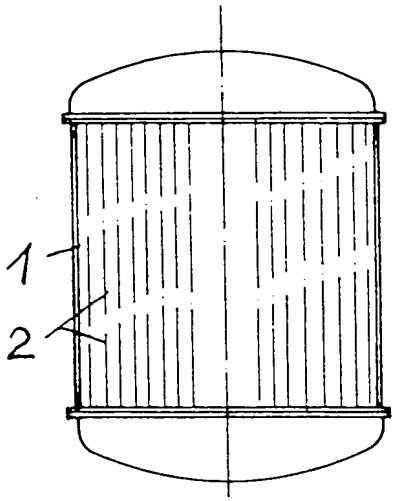


Fig. 3

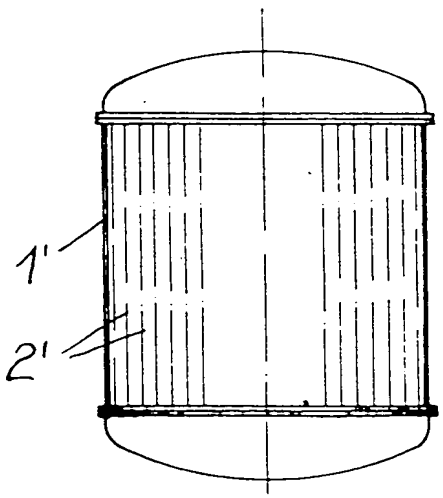


Fig. 2

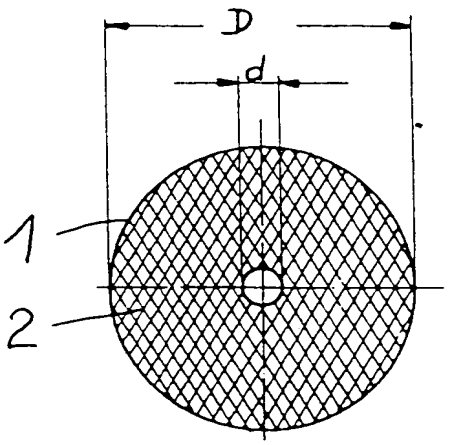
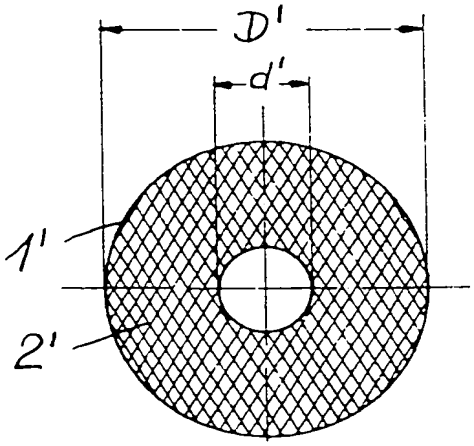


Fig. 4



SPECIFICATION

Improvements in or Relating to Tube Apparatus

The present invention relates to tube apparatus and more particularly to reaction apparatus for carrying out catalytic reactions and comprising a bundle of contact tubes.

Reaction apparatus for carrying out catalytic reactions has been proposed in the form of a contact tube bundle which is disposed between two tube plates, as in the case of other types of heat exchanger. The contact tubes, which are filled with a catalyst, are traversed by a reaction gas, and are exposed on the outside to a heat transfer medium which is usually recirculated. The heat transfer medium passes through a heat exchanger in which it loses the heat which it has received from the contact tubes in the case of exothermic reactions, or receives heat which it gives up to the contact tubes in the case of endothermic reactions.

Such contact tube bundles may be of annular formation for constructional reasons, with the heat exchanger or a supplementary heat exchanger and possibly the circulation means for the heat transfer medium fitted in the central space which is free from contact tubes.

In an attempt to keep the external dimensions of such reaction apparatus as small as possible, the central space free from contact tubes has, hitherto, been made with a diameter only as large as was absolutely necessary for the auxiliary components to be fitted therein.

Sometimes the central space has only been used as a flow channel for the recirculated heat transfer medium. The heat exchanger and circulation unit are then disposed in another position, for example above the contact tube bundle or completely outside the apparatus.

The operating costs of such reaction apparatus is to a large extent dependent on the energy requirement for recirculating the heat-transfer medium. This energy requirement increases with increasing resistance to flow, which is greatest in those regions which the flow direction is transverse to the contact tubes. Usually these regions are in the end zones of the annular contact tube bundle, where the flow is either radially inwards or radially outwards.

In order to decrease the flow resistance in these regions, the flow paths through these regions should be as short as possible, in other words, the radial width of the tube bundle should be kept as small as possible.

According to the present invention, there is provided reaction apparatus for carrying out catalytic reactions comprising an annular contact tube bundle through which a recirculated heat transfer medium can be passed in a radial direction in at least one position, the ratio of the outer diameter to the inner diameter of the annular contact tube bundle being $\leqslant 5:1$.

Further according to the present invention, there is provided apparatus comprising a unitary bundle of substantially parallel heat exchange tubes arranged in an annular array around a central axis with the axes of the tubes being parallel with the central axis, the ratio of the outer diameter to the inner diameter of the annular array being $\leqslant 5:1$.

In certain cases, the diameter ratio may be $\leqslant 4:1$.

The invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Figures 1 and 2 are longitudinal and transverse cross-sections respectively of previously proposed reaction apparatus; and

Figures 3 and 4 longitudinal and transverse cross-sections respectively, of reaction apparatus in accordance with the present invention.

In the previously reaction apparatus shown in Figure 2, the contact tubes 2 disposed in a cylindrical reaction vessel 1 are in the form of an annular tube bundle with an outer diameter D and an inner diameter d. The individual tubes are parallel with the central axis of the annular bundle. The ratio of the outer diameter D to the inner diameter d is 8:1.

The reaction apparatus shown in Figures 3 and 4 similarly comprises a cylindrical reaction vessel 1' and contact tubes 2' disposed therein in the form of an annular tube bundle. In this case, however, the ratio of the outer diameter D' to the inner diameter d' of the tube bundle is 3.5:1.

The manner in which it is possible in practice to make such a reduction in the diameter ratio of an annular contact tube bundle in accordance with Figures 3 and 4 over that shown in Figures 1 and 2 for the same total number of contact tubes, and which advantages derive therefrom, are explained hereinafter with reference to a practical example based on tests.

In reaction apparatus comprising 8000 contact tubes,

in Case a)

the outer diameter (D) of the annular tube bundle	=3600 mm
the inner diameter (d) of the annular tube bundle	= 450 mm
the radial width of the annular tube bundle	=1575 mm
the ratio D:d=8:1 the pressure drop of the recirculated heat transfer medium	= 635 mm F.C.

in Case b)

the outer diameter (D_1) of the annular tube bundle	=3700 mm
the inner diameter (d_1) of the annular tube bundle	= 988 mm
the radial width of the annular tube bundle	=1356 mm
the ratio $D_1:d_1=3.74:1$	
the pressure drop of the recirculated heat transfer medium	= 480 mm F.C.

The pressure drop of the heat transfer medium and consequently the energy requirement for its circulation are thus reduced in case b) by 24% with respect to case A). Similar improvements can also be attained in this manner with different numbers of contact tubes. Furthermore, if required, a still greater total number of tubes can be accommodated by shifting contact tubes from the inside to the outside of the tube bundle, while retaining a reduction in the radial width of the tube bundle. In this case, in addition to a reduction in the energy requirement for circulating the heat transfer medium, there is a simultaneous increase in the capacity of the reaction apparatus.

Furthermore, the invention is applicable to a contact tube bundle either of circular or polygonal periphery, and also with other heat exchangers of corresponding structure and operating conditions.

The reaction apparatus described herein is of the type in which the tube bundle is of unitary construction, that is, it is assembled in one piece rather than in several unitary sectors which are subsequently assembled, this latter construction being proposed for certain very large size apparatus and being not subject to the weight and size requirements which are imposed on smaller apparatus.

Claims

1. Reaction apparatus for carrying out catalytic reactions comprising an annular contact tube bundle through which a recirculated heat transfer medium can be passed in a radial direction in at least one position, the ratio of the outer diameter to the inner diameter of the annular contact tube being $\leqslant 5:1$.

2. Apparatus as claimed in claim 1, wherein the ratio of the outer diameter to the inner diameter of the annular contact tube bundle is $\leqslant 4:1$.

3. Apparatus comprising a unitary bundle of substantially parallel heat exchange tubes arranged in an annular array around a central axis with the axes of the tubes being parallel with the central axis, the ratio of the outer diameter to the inner diameter of the annular array being $\leqslant 5\ 1$.

4. Reaction apparatus according to claim 1, substantially as hereinbefore described with reference to Figures 3 and 4, of the drawings.

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